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ABSTRACT

In examining the issue of why children do so well at language learning despite limited skill and experience, two possible explanations are addressed: one suggests that children learn language well exactly because they are limited, and the other proposes that children are extremely adept at language learning, perhaps more so than adults. Research bearing on this issue in the acquisition of American Sign Language (ASL) verbs of motion and location is described, the structure of these ASL forms is briefly outlined, and other relevant research on language acquisition is reviewed. The research on ASL verbs of motion, which looks at three types of generalizations (holistic iconicity, holistic rote, and morphological analysis), suggests that only children make the most complex of these generalization types. The other research reviewed addresses the acquisition of ASL as a native language from native models, the early vs. late acquisition of ASL, and acquisition of ASL as a native language from late-learning models. It is suggested that the various research findings support the hypothesis that children are smart at language learning but also support the more commonly held view that children are limited to a certain extent, and that further elaboration of the theoretical possibilities this offers is warranted. (MSE)

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Constraints on Learning:
Studies in the Acquisition of American Sign Language

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The issue I would like to address, although unfortunately not resolve, is this: How does the child -- an organism very short in stature, very poor at all the tasks Piaget devised, highly forgetful and motorically inept -- do so incredibly well at language learning? One possibility I would like to suggest is that s/he does so well by being so limited. I will make this suggestion by first reviewing several lines of work which Ted Supalla and I have been conducting on the acquisition of American Sign Language. On the face of it, as you will see, this work appears to suggest exactly the opposite claim, namely that children are extremely smart, at least in language learning, and in fact are much smarter in this domain than are adults. After reviewing this work, however, I will return to the general question, and will try to argue that data such as ours may support the first of these views at least as well as they appear to support the second.

American Sign Language (ASL) is a natural language which has arisen in the visual-gestural modality and is widely used for everyday communication within the deaf community of the United States. It is not pantomime, nor is it a gestural representation of English. Rather, it is a full language, with all of the properties of other languages of the world, but one which has evolved independently of English and is quite different from English in structure. ASL does vary from most other well-studied languages, however, in at least two important ways: first, in modality (it is visual-gestural, rather than auditory-vocal); and, second, in circumstances of acquisition (unlike most spoken languages, a very small porportion of its users have acquired the language in infancy from other native users; most have acquired it in early childhood or later, from models who have previously acquired the language in similar circumstances). Our research has tried to take advantage of these vaiations in both modality and circumstances of acquisition of the language, to examine the effect they have on the course and final outcome of the acquisition process.

Much of our recent research on the acquisition of ASL has concentrated on the acquisition of ASL verbs of motion and location. The reason for this concentration is that verbs of motion in ASL are extremely morphologically complex, but at the same time superficially quite iconic (that is, transparently related to their meanings). Observation of the course of acquisition of ASL verbs of motion can thus help to determine which of various acquisition strategies the learner may take. I will begin the description of our resesearch with an overview of the structure of verbs of motion in ASL.

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ASL Verbs of Motion

Like other signs of ASL, verbs of motion are formed by movements of the signer's hand(s) or other body parts through the space in front of him. In verbs of motion, however, each of the basic phonological (that is, formational) parameters of the sign is itself a morpheme. Figure 1 presents a summary of this morphological structure (for the linguistic details, see Newport, 1981, 1982, and especially Supalla, 1982, in press (a), in press (b)).

Figure 1. ASL Verbs of Motion

HANDSHAPE - classifiers



human

animate non-human

vehicle

MOVEMENT PATH



linear

arc

circle

MANNER OF MOVEMENT



bounce

random

DIRECTION OF MOVEMENT

S.O. HANDSHAPE

S.O. PLACEMENT

ORIENTATIONS

The handshape of the moving, or dominant, hand in the verb of motion is a type of morpheme known as a classifier. Classifiers are found in many spoken languages (although not in English); they mark the classification of the associated noun (in this case, the moving object) as, for example, a human vs. an animate non-human vs. a vehicle. A few of these are schematically illustrated in Figure 1. As is schematized, ASL motion verbs for humans have a handshape in which the index and second fingers are extended downward in a V-shape (representing a two-legged referent). In contrast, motion verbs for

non-human animals have a handshape in which the index and second fingers are bent (representing a crouched referent), while motion verbs for vehicles have a handshape in which the index and second fingers, as well as the thumb, are extended forward (originally representing the hull and mast of a ship). These ASL classifier morphemes are of course considerably more iconic (that is, more representational in form) than most morphemes in spoken languages. Nevertheless, they mark the same semantic distinctions found in classifiers in spoken languages (and no more, even though they could in principle depict a much finer differentiation of referent classes than is typically found in spoken language classifier systems); and they function morphologically in ways that are equivalent to classifier morphemes in spoken languages (that is, for example, appearing as morphemes within verbs of motion, a very common construction in which spoken language classifiers appear). Indeed, they even show many of the historical processes that appear in spoken language classifier systems — for example, the generalization of a ship-classifier to become a classifier for the entire category of vehicles. (See Supalla, in press (a), for a full presentation of classifiers in ASL and their likenesses to spoken language classifiers.) In this sense these ASL handshapes are linguistically the same as spoken language classifiers, despite their iconicity.

In ASL verbs of motion, these classifier morphemes are affixed to a set of movement morphemes, which form the basic stem of the verb of motion and indicate the type of motion undergone by the moving object. The root of the ASL verb of motion consists of one of a small number of possible movement paths (e.g., linear, arc, or circle). Again, a few of these are schematized in Figure 1. If the moving object moves through a linear path, this is marked by a linear movement root in the verb; in contrast, if the moving object jumps, this is marked by an arc movement root, while if it moves in a circle, this is marked by a circular movement root. Simple events of motion include only one movement path; however, more complex events of motion (e.g., jump and then spin) may include a sequence of movement paths. Like the morphemes described above, these morphemes of movement path are highly iconic in form, but in function and structure are linguistically much like morphemes of spoken language; in particular, there is a small number of discretely different movements which can occur, each signalling a category of path types, and a grammatically limited set of possible combinations of these morphemes with one another and with other morphemes of the verb.

Simultaneously affixed to the movement path is a small number of manners of movement (e.g., bounce vs. random vs. roll). If the moving object bounces along its movement path, a bounce manner is produced simultaneous with the path, whereas if it drifts or wanders along its movement path, a random manner is produced simultaneous with the path.

Finally, there are additional morphemes (listed, but not schematized, in Figure 1) which mark the direction of movement of the object along its path (e.g., forward vs. backward), the

classification and relative location of a secondary (background) object (e.g., a vehicle toward which the moving object moves), and the orientations (e.g., up vs. down) of the moving and secondary objects and the path of movement.

In sum, the ASL verb of motion is composed of a number of morphemes. These verbs are like words in spoken languages in that, in both cases, there is a limited number of morphological parameters, and quite a limited number of discretely different morpheme values which is significant along each of these parameters. Moreover, the particular morphological parameters, as well as the particular values along these parameters, are similar across the two modalities. However, in ASL but not in spoken languages, the individual morphemes of verbs of motion are often iconic (that is, the forms are often transparently or translucently related to their meanings); and many of them are typically combined simultaneously rather than sequentially with one another, as are the various features of the referent event of motion (that is, in the verb as in the event, the manner of motion along the path occurs simultaneously with the path movement). These last two characteristics result in the individual ASL verbs of motion often being holistically iconic, even though the set of ASL verbs of motion is more accurately described by non-iconic morphological principles than by iconic relations to their referent events.

The Learning Problem

How might a learner of ASL go about acquiring these verbs? In principle, a learner presented with a sample of these signs could make any of several types of inductive generalization:

1) Holistic Iconicity. The learner could decide that ASL verbs of motion are fundamentally organized by holistic iconicity to events of motion in the real world. That is, s/he could decide that observed verbs are structured by analogue relations to events in the world, and therefore that the correct principle of generalization in predicting novel verbs involves varying the form of the verb continuously, in an analogue fashion, to match the form of the referent event of motion. As will be discussed later, this generalization is the one made by some linguists, in earlier linguistic studies of ASL verbs of motion. Note that this type of inductive generalization would make the learner's model of ASL radically different from spoken languages, which are never organized in terms of either continuous variation in form or analogue mappings with referent properties (and which, to my knowledge, are never hypothesized by learners to have either of these properties).

2) Holistic Rote. The learner could decide that ASL verbs of motion are a set of unanalyzable lexical items, each related arbitrarily and holistically to a set of nonlinguistic circumstances. That is, s/he could decide that observed verbs are each related by convention to a specific set of referent events in the world, and therefore that there is no meaningful sense in which novel verbs referring to new events of motion can be predicted (although, of

course, novel events can always be described by phrases combining known verbs and adverbs). Put more simply, this type of induction involves concluding that each ASL verb of motion is a fixed lexical item consisting of only one morpheme; with neither internal morphological structure nor analogue relations to events in the world, therefore, parts or aspects of its form cannot be manipulated to convey changes in aspects of its meaning. Note that this is indeed the structure of many lexical items in any language, and the structure of most verbs of motion in English. This type of induction involves essentially no generalization, except regarding the range of events to which each observed verb can be applied.

3) Morphological Analysis. The learner could decide that ASL verbs of motion are constructed from smaller morphemic components. That is, s/he could notice that observed verbs are each complex forms paired with complex nonlinguistic circumstances, and that, over a set of these pairs, recurrent components of form are paired with recurrent components of meaning. The generalization here would then be that novel verbs can be constructed by combining these components appropriately in new, but rule-governed, ways. Notice that this type of inductive generalization seems to require a much more complex analysis than do the other types of generalization: here, the learner must attend to patterns over a set of data; and, in order to locate these patterns, s/he must have a tendency to organize the data into paradigms, with holes in the paradigm expected to be filled in. Moreover, the learner must have a tendency to ignore or fail to notice the overall iconicity of individual forms.

In collaboration with Ted Supalla, I have been conducting three lines of research on the acquisition of ASL verbs of motion. In this research, as I will detail below, we have discovered that each of the three types of generalizations reviewed above is made by certain kinds of learners. Most important, our research suggests that young children -- and only young children -- uniformly make generalization type 3. Young children acquiring ASL as a native language uniformly analyze verbs of motion as involving a formal morphological system. In contrast, older children and adults acquiring ASL as their primary language, but not exposed to it until well past infancy, seem predominantly to make generalization type 2, learning verbs of motion as a set of frozen lexical items without a regular internal morphology; and only a small group of linguists (but no natural language learners we have ever studied) make generalization type 1, concluding that ASL verbs of motion are organized in terms of analogue principles of iconicity.

This conclusion is, on the face of it, rather surprising, since I have suggested that generalization type 3 (morphological analysis) seems to require the most complex data-handling and processing abilities, and yet it is accomplished only by the least cognitively capable learners. After reviewing the lines of research and their results, I will return to the question of how to resolve this apparent paradox.

Three Lines of Research on the Acquisition of ASL Verbs of Motion

Before beginning a review of our research on the acquisition of ASL, I would like to mention rather briefly the only finding that I know of relevant to generalization type 1 (holistic iconicity). Our research on ASL verbs of motion began in part because of a challenging claim made by previous linguistic work on these verbs. In particular, DeMatteo (1977) suggested on the basis of an early linguistic analysis of ASL verbs of motion that, unlike words of spoken languages, these ASL verbs were continuously varying forms constructed on the basis of analogue mappings onto real-world events of motion. Our subsequent linguistic analyses (particularly Newport, 1981, 1982; Supalla, 1982, in press (b)), reviewed earlier, has shown that these claims are incorrect; on the contrary, ASL verbs of motion are best described as combinations of discrete morphemes, constructed according to linguistic principles found in the morphological systems of spoken languages. However, for present purposes it is of interest that early linguistic analyses, as well as informal observation, frequently suggested (here and elsewhere in ASL) that the appropriate inductive generalization for ASL involved holistic iconicity. Indeed, iconicity (and especially its refutation as an organizing principle) is a recurrent theme in linguistic work on ASL; see, for example, the thoughtful and seminal work of Klima & Bellugi (1979) demonstrating the failure of iconicity to explain the structure of ASL. What is, to me, of great interest about this fact is that, although iconicity continually catches the attention of linguists and psychologists beginning to study ASL, as well as casual adult observers, it seems never to be the inductive generalization of any group of ASL learners we have observed. In short, no natural language learners seem to make generalization type 1, despite the fact that it is the most striking generalization to many observers. I will return to this point in subsequent sections.

Research on the acquisition of ASL as a native language, from native models. A number of studies of the acquisition of ASL, including some of our own work on the acquisition of ASL verbs of motion, involves young deaf children acquiring the language as a native language from parents and grandparents who are also native users of ASL. (I will refer to this as "native/native acquisition.") Native acquisition of a language from native-speaking models is of course the typical situation for the acquisition of spoken languages. However, for ASL it is not typical and is actually quite rare. Native/native acquisition of ASL occurs primarily when a deaf child is born to deaf parents and deaf grandparents, and therefore enters a family which uses ASL as the everyday and native language of the home. However, as I will detail below, most deaf children are born to hearing families; only 5-10% of deaf children have deaf parents, and even fewer have deaf grandparents as well.

The results of studies of native/native acquisition of ASL are in good agreement: these young children learn ASL in much the way that hearing children learn spoken languages. With regard to the acquisition of complex signs, this process involves the child's

acquiring the formal morphological components of the sign, piece by piece. Nowhere during the acquisition process is there evidence for any tendency to organize signs on an analogue basis; rather, young children seem biased to organize signs in terms of discrete morphological components. For a general review of the literature on the acquisition of ASL, see Newport & Meier, in press; for the details of native/native acquisition of ASL verbs of motion, see Newport, 1981; Supalla, 1982.

Our evidence for this claim (Newport, 1981; Supalla, 1982) is of two types: first, the overall developmental pattern, and second, the types of errors that occur along the way to acquiring complex forms. All of our data on the acquisition of ASL verbs of motion come from elicited production and comprehension tests constructed to evaluate control over these particular ASL verbs. In the production tests, children are shown brief animated films of single events of motion (for example, a hen jumping from the ground to the top of a barn) and are asked to say (in sign) what happened.

The developmental patterns, and the error types produced, form the following picture: The youngest children we have studied produce primarily single morpheme forms: they sign either one morpheme of an adult complex form (e.g., just the path of motion, with an unmarked handshape and with other movement morphemes omitted), or they produce as unanalyzed, frozen amalgams (cf. MacWhinney, 1978) a small number of forms which for the adult would be morphologically complex. In this sense, then, the youngest children appear to be making generalization type 2 (holistic rote), learning a set of unanalyzed lexical forms. However, subsequent stages look very strikingly as though the children move rapidly to comparing forms over the language, and to making generalization type 3 (morphological analysis). In particular, somewhat later in development, children produce partially correct verbs of motion in which some of the target adult morphemes are included, but others are still omitted; still later, there is a small number of interesting errors in which all of the required morphemes are present, but are produced in sequence rather than (as in the adult language) simultaneously. Only fairly late (approximately age 4-5 or later) do they produce large numbers of correct complex forms, with the required morphemes produced simultaneously.

Figures 2 and 3 present two sets of examples, in schematized form, of these various kinds of responses on the morphemes involved in movement. (Full data on the frequencies of these types of errors over age are presented in Newport, 1981, for the acquisition of movement morphemes involved in ASL verbs of motion, and in Supalla, 1982 & in press (b), for the acquisition of handshape and hand placement morphemes involved in ASL verbs of motion.) Both of the examples involve especially complex verbs of motion, in which the adult forms require a sequence of movement paths, several of which additionally involve simultaneous manner and direction morphemes. These complex targets were chosen for illustration because they offer clear examples of both partially correct and sequentialized

responses.

Figure 2. An Example of Native Child Errors

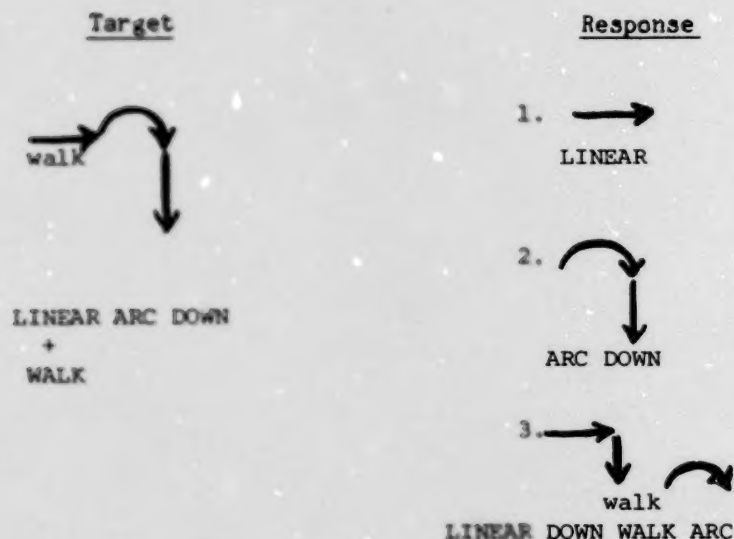


Figure 2 shows the response of an adult native signer, compared with the responses of young deaf children, to a film of a Fisher-Price man walking across the top of a roof and then jumping into the chimney. For present purposes only the verb of motion, and, of that verb, only its movement morphemes, are of interest; all other signs which would ordinarily appear in sentences describing this event, and all other morphemes within the verb, are ignored. The native adult verb of motion for this event (shown as the target) would involve a linear path with a simultaneous walk manner, followed by an arc path, followed by a linear path with a downward direction. The youngest child responding to this film (age 2;4) produced only the linear path, omitting all the other morphemes. A somewhat older child (age 2;11) produced the arc path, followed by the linear path with a downward direction; that is, this child produced several of the required morphemes but omitted several others. A yet older child (age 4;5) produced the linear path, followed by another linear path with a downward direction, followed by the walk manner (produced by itself, with no path movement), and finally the arc path; that is, this child produced all of the required morphemes, but all in sequence, with no simultaneous combinations of movement morphemes where required in the adult target.

Figure 3. Another Example of Native Child Errors

<u>Target</u>	<u>Response</u>
 walk 0 → fast	1.  CIRCLE
CIRCLE WALK 0 → FAST	2.  CIRCLE FAST
	3.  fast  walk  fast CIRCLE CIRCLE CIRCLE FAST WALK FAST

Figure 3 shows the response of an adult native signer, compared with the responses of young deaf children, to a film of a Fisher-Price girl walking slowly, and then gradually moving more and more rapidly, around a circular roll of tape. As in the previous example, only the movement morphemes of the verb of motion will be described. The native adult verb of motion for this event (shown as the target) would involve a repeated circular path with a simultaneous walk manner, along with a simultaneous manner which marks change in speed from unmarked to fast. The youngest child responding to this film (at age 2;6 and again at age 2;11) produced only the circular path, omitting any morphemes of manner. An older child (age 3;6) produced the circular path with a fast manner, omitting the the walk manner as well as the change of speed. Finally, the oldest child (at age 4;5 and again at age 4;11) produced the circular path with a simultaneous fast manner, followed by the circular path with a simultaneous walk manner, followed by the circular path with a simultaneous fast manner. That is, this child produced the required morphemes, but (as in the previous example) digitized several of them in sequence when they should be more simultaneously integrated.

This developmental pattern -- moving from single-morpheme forms to complex forms by adding additional morphemes over time, as well as producing partially correct and sequentialized forms during intermediate stages -- suggests rather strongly that children move from the early holistic strategy to performing a morphological

analysis (generalization type 3) over the set of ASL verbs of motion. Indeed, such productions show a striking tendency to organize the system in terms of the same morphemic components we have presented in our linguistic analyses. They also show a striking disregard for the overall iconicity of the forms, in that the child forms are frequently much less iconic than the corresponding adult forms. Both the types of errors produced, and the ages at which they occur, match those found in the acquisition of morphologically complex spoken languages.

In short, as in the acquisition of morphologically complex spoken languages, young children acquiring ASL as a native language from native models seem biased to organize their signs in terms of a componential morphological system, making inductive generalization type 3 (morphological analysis).

Research on the acquisition of ASL early vs. late in life. The second line of research in which we have been engaged involves comparing native acquisition of ASL with the acquisition of ASL later in life. As mentioned earlier, only a small percentage of deaf individuals (5 to 10%) are born into deaf families, where ASL is used as the language of the home from earliest infancy. Therefore, if we define "native acquisition" as acquisition of a language to which one is exposed from infancy, only 5-10% of the deaf community acquire ASL as a native language (and, as mentioned above and detailed further in the next section, only a small fraction of these have parents who are native signers). Of the remaining 90-95%, most are born to hearing families who have no knowledge of sign language, and many are also too profoundly deaf to acquire English as a native language. Data on English skills among the deaf indicate that most congenitally and profoundly deaf individuals, because of their loss of exposure to auditory stimulation within the speech range, achieve only a rudimentary knowledge of English; even intensive formal instruction in speech and lipreading does not provide most of the deaf community with anything approximating native fluency in English syntax and morphology (for reviews, see Wilbur, 1979, and Quigley & Kretschmer, 1982). These individuals often spend their infancy and early childhood without effective exposure to any conventional language, although they may develop an ad hoc "home sign" system for gestural communication with family members (Goldin-Meadow, 1979; Feldman, Goldin-Meadow & Gleitman, 1978).

Quite commonly, these individuals will be exposed to ASL at school-age or later, when they meet and interact with other deaf children who sign. Since deaf education until recently prohibited signing in the classroom, this exposure has usually taken place in the dormitories or playgrounds of schools for the deaf, where new children are suddenly immersed in a signing environment of their peers. From school age forward, then, ASL is for many deaf people their primary language, the one in which they conduct their social lives outside of the classroom.

In short, unlike virtually all hearing people, members of the deaf community vary widely in when they are first exposed to and

acquire their primary language. They therefore provide us with a unique opportunity to study the effects of early vs. late exposure on the process by which a primary language is acquired, and on the level of linguistic fluency which is ultimately achieved.

Our studies thus far have concentrated primarily on deaf adults, to observe the asymptotic state achieved in knowledge of ASL as a function of the age at which exposure to ASL began. Our data from work in progress (Newport & Supalla, forthcoming) come from 46 subjects ranging in age from 20 to 77 at the time of testing. All of the subjects were either born deaf or became deaf before acquiring English, and all have been immersed in the deaf community, using ASL as their primary language, from the time at which their exposure to ASL began until the present. They fall into three groups in terms of the age at which they were first exposed to ASL: 1) native learners, exposed to ASL (by their deaf parents) from birth; 2) early learners, exposed to ASL (by deaf peers) beginning at age 4-6, when they began to attend a residential school for the deaf; and 3) late learners, exposed to ASL (by deaf peers) beginning at age 12 or later, when they began to attend a residential school for the deaf or joined a deaf signing social group.

To be sure of observing effects of the age of exposure to the language, and not effects of the (somewhat correlated) length of experience with the language, our subjects in each of these learning groups were chosen to fall into two groups in terms of length of experience with ASL: some of them were young adults (22-34 years old), who had been using ASL as their primary language for approximately 5 to 30 years; the remainder were older adults (47-77 years old), who had been using ASL as their primary language for approximately 40 to 70 years.

All subjects were given the same elicited production and comprehension tests of ASL verbs of motion mentioned above for children. The production test has already been described. The comprehension test involved presenting to subjects a series of short films, each consisting of a native signer producing a single ASL verb of motion; after each verb, the subjects were asked to choose an appropriate object from a small set and make it perform the action described.

Table 1 presents the results of the production test; table 2 presents the results of the comprehension test. Both tables show these results for the three learning groups (native vs. early vs. late learners). These data are averaged over the two levels of experience, since there were no differences between moderate and massive amounts of experience with the language. The data presented are the percentage of morphemes produced or comprehended correctly, according to our linguistic analysis of the adult language as used by our native signing informants; that is, the data are scored relative to the way a native signer would respond. All of these data are still preliminary and will undergo refinements in scoring prior to their publication.

Table 1. Production of ASL Verbs of Motion
by Three Groups of Learners
(% correct)

	<u>Linear</u>	<u>Manner</u>	<u>CO HS</u>	<u>SO HS</u>
Native	.93	.90	.75	.80
Early	.89	.76	.65	.70
Late	.79	.62	.52	.46

Table 2. Comprehension of ASL Verbs of Motion
by Three Groups of Learners
(% correct)

	<u>Path</u>	<u>Manner</u>	<u>CO HS</u>	<u>SO HS</u>
Native	.91	.94	.88	.89
Early	.85	.92	.84	.75
Late	.82	.93	.68	.49

These tables show a consistent pattern on virtually every morpheme tested, in both production and comprehension: native learners score better than early learners, who score better than late learners, even after all the subjects had been using ASL as their primary language for more than 40 years. On the measures presented, all of the differences between groups of learners except one (comprehension of manner) represent significant linear trends over age of learning, with no effect of length of experience with the language. In short, there is a sizeable effect of when one begins learning the language on the level or type of linguistic knowledge achieved.¹

One important question involves how to describe, qualitatively, the differences between native and late learners that are reflected in these numbers. The data show that later learners look worse than earlier learners when they are scored relative to the native ASL system. But does this mean that they have in fact gone about learning the language in the same way as earlier learners and simply failed to master this system as well, or rather that they have learned the language in a different way?

A way of addressing this question is to compare the late learners' performances, particularly with regard to the types of errors made, with native learners at comparable levels of morpheme

accuracy. That is, how do adult late learners (who are scoring at 40 to 60% correct on many morphemes) compare with child native learners (who, at about age 3 to 4 1/2, are scoring at about the same level of morpheme accuracy)? In the previous section I described the types of errors made by young native learners of the relevant age: young native children, in the midst of acquiring ASL, make errors that involve producing some component morphemes while omitting others (omission of morphemes), and producing all the component morphemes sequentially rather than simultaneously (sequentialization, or separation, of morphemes). Both of these types of errors suggest that native learning children are organizing their signs in terms of these components, and are in the midst of acquiring the full set of components and the ability to produce them in a coordinated fashion. In contrast, the adult late learners show a very different distribution of error types, suggesting that the process by which they have organized and acquired the language is also quite different.

Although the adult late learners have some occurrences of the types of errors shown by native children, these are relatively rare. Instead, their predominant errors involve producing various kinds of frozen forms. As one type of example, there are in ASL (even for native signers) a number of signs which are not constructed by combining component morphemes, but rather consist of only a single morpheme. Some of these single-morpheme signs (e.g., the sign GO) are from portions of the lexicon outside of that organized by the morphology of verbs of motion. Others are forms which, for native signers, appear to come from the morphologically constructed verbs of motion, but are morpheme combinations used so frequently that they have become frozen in meaning. For example, the sign FALL (consisting of a downward V-handshape, moved along an arc + a pivot path) for native signers can be viewed as constructed from a classifier morpheme for HUMAN, a path morpheme ARC, and a manner morpheme PIVOT (or ROTATE); however, it is commonly used as an unmarked form meaning "fall," regardless of the class of objects undergoing the action or the actual path or manner of motion traversed. (This is quite analogous to the occurrence of frozen forms in spoken language; for example, the English word blackboard, which, although initially formed as a productive compound of the morphemes black and board, is now commonly used without regard to whether the writing surface is indeed black (as in green blackboards) or a board (as in flexible toy blackboards for children).) Both of these kinds of single-morpheme forms are used by native signers; but they are used strikingly more frequently by adult late learners.

Moreover, there are several other kinds of frozen forms which are commonly used by late learners, but which are seldom or never used by native signers. These types of productions suggest that the overall high frequency of frozen forms in late learners is not merely a stylistic preference, but rather an indication of a lack of analysis of the language. As an example, late learners frequently produce forms which are phonologically similar to (but not identical

with) common frozen signs; however, these variations in form are not in any systematic way related to variations in meaning. Thus a late learner may produce variants of FALL with a DOWNWARD LINEAR movement (rather than an ARC movement), or without the PIVOT manner. Were these forms to be produced by the native signer, they would be used for events which likewise varied in certain ways (e.g., DOWNWARD would be added when the object's movement was basically downward); and such consistent relations between components of form and components of meaning would give evidence of a morphological system underlying the individual signs. However, many late learners appear to use these variations in form quite haphazardly with respect to referent events, with no relations we can observe between particular variations in form and particular variations in meaning. For such learners, DOWNWARD might (or might not) occur as part of the sign FALL when the event involved an object falling upward and not downward (e.g., falling upward on stairs). For these learners, then, there appear not to be analytic relations between components of form and components of meaning in this set of signs. Instead, they appear to have learned several unanalysed forms, each applying to some set of nonlinguistic events, with possible overlaps in the referent events for different forms. With responses of this kind, late learners will achieve test scores at moderate (that is, low but non-zero) levels of accuracy, when evaluated in comparison with native responses; but their responses will have come from a set of generalizations with a very different character than those of native signers.

In short, unlike native learners, adult late learners seem to produce a large number of signs which are holistically related to their meanings, and which are not constructed from a set of component morphemes. That is, unlike young native learners, adult late learners appear to continue throughout the acquisition process making generalization type 2 (holistic rote); they appear much less likely than native learners to make generalization type 3 (morphological analysis), and much less frequently organize their signs in terms of morphemic components. Learners who have learned the language sometime between native and late acquisition look intermediate between these types, with more holistic organization the later the language was learned.²

Thus far, if my arguments are correct, we have seen the following: Young children learning ASL as a native language from native models organize ASL verbs of motion as constructed from a system of morphemic components. In contrast, individuals learning ASL as a primary language, but not exposed to it until later in life, organize ASL verbs of motion as a set of frozen lexical items without a regular internal morphology (at least they appear to organize verbs in this fashion by the time we test them in adulthood; presumably this reflects the way they have organized them during the learning process). This kind of organization is, however, a matter of degree: the later their exposure to the language, the greater the degree of holistic organization.

Before turning to consider why these differences occur, I must mention one last line of research.

Research on the acquisition of ASL as a native language, from late-learning models. Our third line of research, still very much in progress (and therefore reported on here only briefly) involves young deaf children acquiring ASL as a native language, but from parental models who were themselves not native learners of ASL. As described above, only 5 to 10% of deaf individuals are born to deaf parents, and only a small fraction of these have deaf grandparents. The rare deaf children with deaf parents and deaf grandparents, learning ASL as a native language from native models, have already been discussed in the section on native/native acquisition. Here, however, we consider the remaining (and more numerous) deaf children with deaf parents, namely those with hearing grandparents. These children, although themselves native learners of ASL, have parents who are not native learners; they are acquiring the language from earliest infancy, but from models who acquired the language relatively late in life. (I will refer to this as "native/late" acquisition.)

If my description of non-native signing was correct, these children are receiving an input consisting predominantly of forms related holistically, and not componentially, to their meanings. Nevertheless, the input does include probabilistic (if somewhat inconsistent) relations between components of form and meaning. This input situation is thus comparable to that of creolization, where native learning children are exposed only to input from a non-native user, and where the input language (in the creolization situation, a pidgin) is variable and not fully grammaticalized in structure.

Our preliminary results, from observing the acquisition of ASL verbs of motion in native/late as compared with native/native learners, suggest that the developmental patterns in these two situations are much the same, and that the types of linguistic knowledge ultimately achieved are also much the same. Young children acquiring ASL as a native language appear to organize verbs of motion into a componential morphological system, even when their input does not strongly support such an analysis. In short, young children acquiring ASL as a native language uniformly make generalization type 3 (morphological analysis), regardless of whether their input is in fact organized according to this generalization.

Summary of the results of these three lines of research. To summarize, I have suggested three types of inductive generalization that might be made about ASL verbs of motion, and I have tried to argue that different kinds of learners actually make these generalizations. Generalization type 1, that signs are organized in terms of their holistic iconicity to real-world events, is apparently made by none of our natural language learners, but has been suggested by early linguists observing ASL. Generalization type 2, that signs are a set of frozen lexical items organized in terms of their holistic rote relations to real-world events, is made by late learners of ASL. Most important, generalization type 3, that signs form a morphological system and are organized in terms of regular

internal form-meaning components, is the generalization made uniformly by children and only by children. This last generalization is consistently made by young children acquiring ASL as a native language, despite the alternatives made available by the modality; despite the fact that older learners, also acquiring the language as their primary communication system, find other generalizations more attractive; and despite an input model which may in fact be organized differently.

Candidate Explanations

The conclusions drawn above are paradoxical, in that the type of inductive generalization that seems the most complex is made only by the learners with the fewest cognitive capabilities. To make this paradox more apparent, let me sketch what appears to be involved in performing a morphological analysis.

First, the learner must store information regarding the complex forms s/he has seen in relation to some information regarding their meanings or referents. (This part of the process must of course occur in any of the types of learning.) Beyond this, however, the learner must somehow organize these complex form-meaning pairs in sets or families, within which portions of the complex forms and/or portions of the complex meanings are shared. (In contrast, a learner who was not biased to perform a morphological analysis, but who instead tended to retain items holistically, need only store each individual form in relation to its meaning, and need never relate or compare these individual lexical items to one another.) Finally, the learner must perform some type of analysis that isolates component pieces of form which are consistently related to component pieces of meaning over these families; indeed, the native learner apparently performs this analysis in such a way that some striking degree of inconsistency in this relationship goes unnoticed. Apparently when the data do not fully support such an analysis, they are pushed and pulled until they do; irregularities are either not stored or are ignored, and semi-regularities are somehow exaggerated. The outcome of such processes is then a set of components from which complex lexical items are constructed.

None of this sketch should be taken to suggest actual processes by which such steps are performed; they may be implemented in a variety of different ways. Regardless of the details of implementation, however, it is hard to avoid the impression that performing a morphological analysis is more complex than not performing one. And yet the particular learner I have claimed always performs such an analysis (that is, the young child) is an organism usually described as having noticeably less processing and memorial abilities than the learners who I have claimed do not perform such an analysis (that is, older children or adults). I would like to consider two quite different kinds of resolution to this paradox.

One way of understanding these facts -- what is probably the traditional kind of explanation in the field -- is to claim that the young child has a special island of competence, particularly relevant

to language learning, in the midst of a sea of otherwise very limited skills (cf. Chomsky, 1965, 1975). This special competence may be strictly circumscribed to language learning, or it may be somewhat more general (e.g., a special tendency to systematize certain types of patterned data; cf. Newport, 1982). What is crucial to this view for present purposes, however, is that there is a dissociation between the child's highly developed capacities with regard to language learning, and her much more limited capacities in many other domains. On such a view it is thus coincidental that this special competence in language learning declines or disappears just as the child grows more capable in many nonlinguistic abilities, so that the older child or adult, who is generally superior to the young child in almost every other task, is inferior at the particular task of language learning.

There is, however, a second and quite different way of viewing these facts, which has been given hardly any consideration in language learning but which has occasionally been thoughtfully proposed in other areas of development. This second view involves claiming that the very limitations of the child provide the bases on which to perform successful language learning, and that indeed without these limitations (as in the older child or adult) the acquisition of some aspects of language is more likely to fail. In short, this view entails not a dissociation, but an intimate connection between the child's (good) capacities for language learning and her (poor) capacities for many nonlinguistic skills.

One presentation of this second view, but with regard to perceptual development rather than language learning, is in an extremely interesting and provocative paper by Turkewitz & Kenny (1982). These authors have suggested that there may be a positive evolutionary advantage for infancy, and particularly a beneficial effect of the infant's sensory limitations on perceptual development and organization. As an example, they suggest that the infant's limited visual acuity results in his resolving only relatively large objects or large features, which may help to organize the sensory stimulation with which he must deal later in development. More generally, Turkewitz & Kenny are essentially suggesting that the limitations of the infant provide a very special setting for the development of complex skills, in that they result in selecting certain portions of the environment for processing while leaving other portions unprocessed.

One might view Slobin's (1973) operating principles for language acquisition in a similar light (although, it must be noted, Slobin himself does not subscribe to this view [personal communication]). That is, these operating principles may be seen as explicating the ways in which very limited attentional and memorial resources are distributed during language processing so as to direct acquisition in particular uniform ways. If perception and memory were unlimited, acquisition might not only look quite different in its course, but might possibly be less successful.

I would like to suggest an explanation of our ASL data within

this second view: namely, that the various perceptual and memorial limitations of the young child help to promote a successful morphological analysis of the language, whereas having a less limited set of capabilities may make the analytic task more difficult. On this hypothesis, the cognitive limitations of the child may be crucial for successful learning of certain kinds of skills (for example, those that involve locating the components of complex stimuli), at the same time as they are detrimental to other kinds of skills (for example, those that require broad integration, or simultaneous adoption of multiple perspectives).

In more detail, when the child learner stores complex forms and their meanings, it may sometimes be the case that whole forms and meanings are perceived and retained, but more frequently must happen that only portions of form, and portions of the related nonlinguistic events, are processed and remembered. If this is true, the child's mental corpus must contain more pieces of form and of meaning than were objectively presented. I assume that the psychological processes which determine how a complex linguistic form or nonlinguistic event will be segmented by a limited perceptual or memorial system bear some sensible relations to the way the form or event is segmented within the language (this is of course not obvious and may be false). If this assumption is correct, however, these pieces of form and of meaning may provide the child with a way to break the morphological code of the language. That is, rather than storing sets of complex form-meaning pairs and then somehow finding within these complex stimuli the subparts which such pairs share, the child learner may often store components directly, and may thereby be in a better position to note when these components appear within more complex forms. In contrast, the more capable adult may more frequently store whole forms and meanings, and may thus, because of his greater capabilities, face a more difficult analytic task. In addition, the adult may be more capable of noticing holistic form-meaning relations (of either the iconic or the rote type) which the child will overlook.

Our data do not clearly support one of these views of language acquisition over the other; and I personally waver between these views with great regularity. My point, however, is that we have not often considered the second view at all within language acquisition, despite what seems to me its appealing reconciliation between language learning and other aspects of development. Our research on the acquisition of ASL under various circumstances of learning suggests that we must devise theories of maturation and/or learning which can account for two important facts: first, that very young children uniformly acquire natural languages in certain ways, and second, that older, wiser, and more sophisticated adults do not. Such facts require either a theory that grants young children special and highly developed capabilities for language learning which diminish with maturation, or a theory that suggests that there might be advantages for language learning in being very tiny and not so smart.

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Footnotes

1. There are of course numerous differences between learning a language as an infant and learning a language as an older child or adult. It is therefore, of course, possible that the observed differences in outcome are a function of some difference in the learning situation other than that related directly to the age of learning. For example, it has been suggested in the second language learning literature that differences in learning a second language at various times of life may be due to differences in the input other speakers direct to learners of various ages, or to differences in knowledge of (and therefore interference from) a prior language. In the ASL situation, at least the latter of these alternative explanations is quite a bit less likely, since, as mentioned previously, the evidence regarding knowledge of English suggests that deaf children are not learning very much English prior to their acquisition of ASL, and moreover that there is not enough improvement over age in knowledge of English to account for the decline in learning of ASL.

However, in the ASL situation there are new differences between early and late learning which the reader might think could be responsible for the observed differences in outcome: for example, whether the learners are primarily acquiring the language from adult models (this is the case for native learners) or from child models (this is the case for non-native learners), or whether the learners have intellectually suffered from language deprivation for differing lengths of time and are therefore cognitively different in their abilities to acquire new knowledge. In our opinion, neither of these types of explanations is adequate to explain our data, as we now detail.

With regard to differences in models, it is true that native learners

differ from other learners in whether their models are adults; however, early and late learners do not differ consistently or in the same direction in this regard (both groups learn the language primarily from other children, with late learners probably learning from older children), yet our data show a consistent decline on our tests, from native to early to late learners. In a related vein, it has been suggested to us that our results may reflect differences in the fluency of the models to which these learners are exposed. However, the facts again seem to be at odds with this explanation: all the groups were primarily exposed to and learned from non-native models (our native signers in this study were not native/native acquirers; they all have hearing grandparents and therefore non-native parents—see the next section for further details on this issue); and, since our data show greater fluency for learners who begin earlier in life, early learners (usually having other early learners as models) and not native learners (having either early or late learners as models) may be the group with the most fluent models.

Finally, with regard to possible cognitive deficits resulting from differing amounts of linguistic deprivation, there are two sets of facts at odds with this explanation of our data. First, the available evidence on cognitive abilities of deaf children suggest a possible intellectual advantage for native signers vs. others; but there is no evidence of differences between early and late learners (see Quigley & Kretschmer, 1982, and Newport & Meier, in press, for a review). Second, there is no evidence within the literature on language learning in hearing populations to suggest an effect of intellectual abilities (even including a surprising range of mental retardation) on language learning abilities. Thus there is no reason to suppose that our subject groups differ in ways that would be relevant to explaining their differences in ASL.

In sum, although we cannot rule out alternative explanations, we do not find them sufficiently in accord with our data to suggest that they are correct. In addition, the consistency between our data and the available evidence on asymptotic learning of a second language by hearing people as a function of age of acquisition (cf. Krashen, Scarcella, & Long, 1982; Johnson & Newport, in progress) also suggests that alternative explanations are inadequate, since most of the alternative explanations that seem viable for one of these situations are not viable for the other. As examples, note that the interference explanation might work for second language learning but not for ASL learning, whereas the deprivation explanation might work for ASL learning but not for second language learning.

2. As this last statement suggests, all of the phenomena described for late learners are probabilistic rather than absolute. That is, it is not the case that late learners totally lack a morphological analysis of ASL; rather, they appear to have analysed much less of

the language than have native learners, and have a much larger repertoire of unanalysed forms. As is stated in the text, learners exposed to the language at intermediate ages appear to have performed intermediate degrees of analysis. Moreover, added on top of these probabilistic characterizations is a degree of individual difference which seems also to be linearly related to age of exposure: while native learners look fairly uniform in performance, late learners show quite a bit of individual difference, with some showing much more analysis than others.

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